Department of Agriculture, Trade and Consumer Protection
Division of Agricultural Development
Agricultural Development & Diversification Program (ADD)
Grant Project Final Report

Contract Number: 21084 Purchase Order Number: AGG000094

Grant Project Title: Chapman Brothers Farm & USEMCO Anaerobic Digester Design Project

Amount of Funding Awarded: $17,500.00

Name of Principal Contact Person: Duane Chapman / Patrick D. Rezin

Organization: Chapman Brothers Farms / USEMCO

Email Address: Duane Chapman chapmanfarms@centurytel.net
Patrick D. Rezin prezin@usemco.com

WEB Address: www.usemco.com

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Please use the following questions as a guide for writing your grant project final report. In your final report, please answer each question as it relates to your grant project.

1) What was the original intent of the grant?
   - What did you want to accomplish with the grant?
   - How was it expected to benefit Wisconsin Agriculture?
   - What makes this project work important or significant?
2) What steps did you take to reach your goal?
   - What worked?
   - What challenges did you face?
   - What would you do differently?
3) What were you able to accomplish?
   - What are the results from this project?
   - Include any analysis of data collected or materials developed through project work.
4) What conclusions can you make based on project work the analysis of collected data?
5) What do you plan to do in the future as a result of this project?
6) What information or additional resources are needed to commercially develop this enterprise?
7) How should the agricultural industry use the results from your grant project?

Chapman Brothers Farm and USEMCO have been working together the last two to three years on design a cost-effective, modular, factory built manure anaerobic digester that is affordable for smaller dairy farms with less then 1000 animal. During the summer of 2006 USEMCO manufacturer and put into operation be a scaled-down 100 gallon prototype anaerobic digester. From the prototype

digester we had hope for some operating data that would aid in designing a full-scale digester. As it turned out this digester had serious plugging problems. Due to these problems we were unable to collect sufficient operating data such as feed rates, methane gas production, and volatile solid destruction to design a full-scale digester. However, some other very important lessons were learned from the plugging. We realized that centrifugal pump was not adequate to pump small measurable portions of manure into the digester. We were unable to locate an economical positive displacement pump that would pump small portions at the required head condition. USEMCO designed and manufactured a small piston pump to accomplish this. Piping size was definitely an issue. We were using 1-1/2 inch diameter PVC piping. Due to the size of the sawdust bedding particles and the fiber present in the cow manure a bridging or interlocking affect of these particles would cause the plugging. It was not practical to go with larger piping because the flow rates would be so low that solid would settle out causing plugging as well, so flushing ports were added. With a larger digester this should be less of a problem because you will have larger piping with higher flow rates preventing bridging and/or interlocking and particle settlement. Similar plugging problems were observed with the outlet of the digester. Even with all the difficulty we had, we did generate some burnable methane gas. We did not have a quantitative or qualitative analysis of the gas from this digester

In the summer of 2007 USEMCO manufactured and put into operation a 1000 gallon digester, 10 times larger then the first one. Plugging problems were not eliminated but were significantly reduce. The piping size was increased to 2 inch diameter and as much as possible the inlet and outlet pipelines layout in straight lines. When bends or elbows were required either long radius 90 degree elbows or multiply 45 degree and 22.5 degree elbows were utilized to allow for gradual change in direction. The one area that generated the majority of the problems was with the check valves. The check valves were modified with flushing ports. Daily flushing was done to keep valves functioning properly. Once the plugging problems were under control we could monitor the feed rate, temperature and gas production. The digester was operated at the mesophilic temperature range around 100ºF. The mesophilic temperature was chosen rather then the thermophilic, 140ºF, is because it is easier maintain the mesophilic temperature and it is similar temperature of a cows system and bacteria would be more natural and assumed it would be less sensitive to changes.

The 100 gal digester we started out with a hydraulic retention time of 34 days, then ramping it up to a 5 day retention time. It initially took about a month before we obtained burnable methane gas. As we ramped up the feed rate we generated less gas. We had no burnable gas at 5 day retention time. The retention on the 1000 gallon digester ran from 35 down to 5 days. Again it took about 30 days to get

burnable methane gas. In both cases we used a culture from other operating anaerobic digesters to help get them started. We had burnable gas at 5 day retention time but it was very week. The strongest flame appeared to be around the 20 day retention time. At this point we took samples of the gas, raw manure and the treated manure for testing. The gas analysis came back with a 72.7% methane content. We were expecting to get somewhere in the 50 to 60% range. The Biochemical Oxygen Demand was reduced from 22,400 mg/L to 2,170 mg/L. Chemical Oxygen Demand was reduced from 48,700 mg/l to 22,400 mg/L. Solid were reduced from 5.14% to 2.05% (by weight) and Total Volatile Solids were reduce from 80.1% to 69.7% (by weight).

The two major issue need to be resolved to make anaerobic digestion to be feasible for small farms is cost and daily maintenance. Certainly up scaling that system, using larger diameter pipe and increasing the flow in and out of the digester should have a positive impact on plugging. Operating a digester during the summer is one thing. However, running one during the winter is going to present a lot of new problems. Digesters cannot be turned on and off if something breaks; they need to run continuous year round night and day.

We do want to take this to the next level by putting into operation a 30,000 gallon digester that could run through the winter months.